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Research Note

Human Pinworms Collected from a Chimpanzee, *Pan troglodytes,* in a Zoo of Okinawa, Japan

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ABSTRACT: *Enterobius vermicularis* (Linnaeus, 1758) and *Enterobius gregorii* Hugot, 1983 (Nematoda: Oxyuridae), were collected from a chimpanzee, *Pan troglodytes,* reared in a zoo of Okinawa, Japan. This is the first record of *E. gregorii* from chimpanzee. The male of *E. vermicularis* was significantly larger than that of *E. gregorii.* The 2 species were readily distinguished by the shape and length of the basal portion of the spicule while the morphology of the distal tubular portion was identical. The spicule in the males immediately after the final molt had only a distal tubular portion, indicating that the basal portion develops during the subsequent maturation process. Presence of intermediary forms of the basal portion between the typical *E. vermicularis* and *E. gregorii* types suggests that the basal portion of the former grows from that of the latter.

KEY WORDS: *Enterobius vermicularis, Enterobius gregorii,* morphology, chimpanzee, zoo.

Two species of human pinworms have been recognized, namely, *Enterobius vermicularis* (Linnaeus, 1758) and *Enterobius gregorii* Hugot, 1983. The males of the 2 species are easily distinguished from each other by the length and shape of the spicule, while no morphological feature has been found to discriminate their females (Hugot, 1983; Hugot and Tourte-Schaefer, 1985). *Enterobius gregorii* seems to have worldwide distribution because its occurrence, often concurrent with *E. vermicularis,* has been recorded from various geographical regions (Chittenden and Ashford, 1987; Barnish and Ashford, 1989; Pampiglione et al., 1989; Hasegawa et al., 1991; Mangali et al., 1993). Besides humans, some nonhuman primates under captive condition have been known to harbor *E. vermicularis* (cf. Rewell, 1948; Sandosham, 1950; Kosuge and Miyamoto, 1984). However, it has not been elucidated whether or not *E. gregorii* is also parasitic in such primates. Recently, we had an opportunity to examine pinworms expelled from a chimpanzee, *Pan troglodytes* (Blumenbach, 1775), in a zoo of Okinawa, Japan, and found *E. gregorii* along with *E. vermicularis.* A close examination also raised a question as to the distinctness of *E. gregorii* as discussed herein.

The pinworm infection was proved by a fecal examination of the female chimpanzee with anorexia in the middle of April 1995. This chimpanzee had been reared for more than 14 yr and developed a coprophilic habit. An anthelmintic, pyrantel pamoate, was given orally with food on 24 April and 22 May 1995, and the fecal masses found on the floor of the chimpanzee pen were collected on the next morning. The feces were fixed in 5% formalin solution at room temperature. The fixed feces were gently washed on a stainless-steel sieve with a pore size of 0.075 mm. The residues left on the sieve were then transferred to a petri dish and examined under a stereomicroscope for pinworms. Collected worms were rinsed in 70% ethanol, cleared in a glycerol–alcohol solution, and mounted on glass slide with 50% glycerol aqueous solution. To examine the pericloacal morphology, the posterior body was severed and cut horizontally and mounted with the ventral side up. Observation was made with a Nikon Optiphoto microscope equipped with a Nomarski interference apparatus. Statistical comparison of measurements was made by Welch's test. Representative specimens were deposited in the U.S. National Parasite Collection, Beltsville, Maryland, Nos. 85455–85457.

Numerous immature adult pinworms, immediately after the final molt, as well as many fourth-stage larvae were recovered from the feces collected on 25 April 1995, and many mature males and immature females were collected from the feces of 23 May 1995. They were apparently human pinworms because the distal end of the spicule formed a recurved hook (Figs. 1–4), being clearly distinguished from the chimpanzee pinworm, *Enterobius anthropopitheci* (Gedoelst, 1916), of which the spicule has a round distal end (Hugot, 1993). All of the males collected on 25 April 1995 had a simple tubular spicule that

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Figures 1–4. Spicules of pinworms collected from a chimpanzee, *Pan troglodytes*. 1. Male immediately after final molt. 2. Male of *E. gregorii*. 3. Male of *E. vermicularis* with developed basal portion. 4. Male of *E. vermicularis* with small basal portion. Closed arrows indicate the distal tubular portion and open arrows indicate the basal portion. Scale bar = 50 μm.

was morphologically identical to that of *E. vermicularis* and *E. gregorii* (Fig. 1). Measurements are stated in Table 1.

The males collected on 23 May 1995 were readily divided into *E. gregorii* and *E. vermicularis* based on the criteria of the spicule morphology proposed by Hugot and Tourte-Schaefer (1985). The spicule was composed of a distal tubular portion and a basal portion (Figs. 2, 3). The basal portion of *E. gregorii* was a round refractive mass (Fig. 2), and that in *E. vermicularis* was elongated and sac-like, filled with various amounts of refractive material that extended from the basal end of the distal tubular portion (Fig. 3). Meanwhile, the morphology of the distal tubular portion was identical between *E. gregorii* and *E. vermicularis* (Figs. 2, 3). In some *E. vermicularis,* the basal portion was still small and differed from that in *E. gregorii* only by a slight dorsal protrusion and a sac-like structure (Fig. 4). Although Hugot and Tourte-Schaefer (1985) claimed that the fine pericloacal morphology in males was different between the 2 species, such difference was not observed in the present examples.

With the exception of the length of the distal tubular portion of the spicule, all of the mean measurements of the immature males collected on 25 April 1995 were significantly smaller than those of *E. gregorii* collected on 23 May 1995 ($P < 0.0001$). Again, all of the mean measurements, except the spicule distal portion length, of the *E. gregorii* males were significantly smaller than those of *E. vermicularis* collected on the same day ($P < 0.01$). The mean length of the distal tubular portion of the spicule showed no significant difference between the immature males of 25 April 1995 and *E. gregorii* of 23 May 1995 and between *E. gregorii* and *E. vermicularis* of 23 May 1995. However, the distal portion of the spicule in the immature males was smaller than that of *E. vermicularis* ($P < 0.01$).

The difference in the worm size of males of the species was already noticed by Hasegawa et al. (1991), who recorded the body length of *E. vermicularis* and *E. gregorii* from an Okinawan woman to be 2.33–2.85 mm (mean 2.61) and 1.25–2.45 mm (mean 1.94), respectively. Hugot and Tourte-Schaefer (1985) also reported that the maximum body length of *E. vermicularis* was much larger than that of *E. gregorii* (3.845 vs. 2.8 mm). Although the minimum body length of *E. vermicularis* in their report was shorter than that of *E. gregorii* (0.92 vs. 1.37 mm), it is surmised that some males of *E. vermicularis* examined by them were much shrunken. This presumption may be supported by the fact that the male of *E. vermicularis* illustrated had a shorter

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Table 1. Measurements of male pinworms expelled from a chimpanzee, *Pan troglodytes*. Mean ± SD (range) in micrometers.

Date of Collection: No. measured:	*Enterobius* sp. 25 April 1995 25	*E. gregorii* 23 May 1995 25	*E. vermicularis* 23 May 1995 25
Body length	1,556 ± 90 (1,380–1,730)	1,949 ± 193 (1,550–2,490)	2.321 ± 210 (1,970–2,740)
Body width	103.6 ± 10.4 (83–126)	155.1 ± 21.1 (112–119)	183.1 ± 22.7 (141–230)
Esophagus			
Total length	408.9 ± 19.6 (358–435)	506.2 ± 22.6 (460–550)	536.3 ± 24.6 (480–590)
Bulb length	92.4 ± 34 (86–99)	106.6 ± 4.4 (96–115)	110.6 ± 4.5 (99–122)
Bulb width	61.0 ± 2.7 (53–66)	75.0 ± 5.2 (60–86)	80.2 ± 6.2 (64–97)
Nerve ring*	109.5 ± 5.7 (101–125)	131.5 ± 9.1 (112–153)	138.6 ± 8.8 (115–154)
Excretory pore*	426.2 ± 28.9 (385–483)	587.3 ± 40.6 (510–653)	656.8 ± 57.2 (550–736)
Spicule length			
Total	70.6 ± 2.4 (64–74)	78.0 ± 2.7 (69–83)	96.6 ± 4.4 (82–106)
Distal portion	70.6 ± 2.4 (64–74)	71.3 ± 2.6 (66–76)	72.4 ± 1.9 (69–75)

* Distance from anterior extremity.

but thicker body than *E. gregorii* (see table 1 of Hugot and Tourte-Schaefer, 1985).

Because the immature males immediately after the final molt lack the basal portion of spicule, it is apparent that this structure is formed during the subsequent maturation process. It would be thus expected to find various stages of development in the basal portion of *E. vermicularis*. However, only observed stages were the intermediate forms between the typical *E. vermicularis*–type and the typical *E. gregorii*–type basal portions (Fig. 4). It is therefore surmised that the *E. vermicularis*–type basal portion grows secondarily after the *E. gregorii*–type basal portion is completed. If this is the case, *E. gregorii* might be regarded as a developmental stage of *E. vermicularis*. The smaller body size of *E. gregorii* seems to support this possibility.

The association of *Enterobius* and primates has been considered as a good example of coevolution (Brooks and Glen, 1982). The establishment of *E. gregorii* has led evolutionary biologists to make an alternate hypothesis of the coevolutionary history of *Enterobius* and primates (Brooks and McLennan, 1993). However, further investigations are required to prove the distinctness of *E. gregorii* because the present results suggest its synonymy with *E. vermicularis*. Unfortunately, the pinworms expelled from humans are usually damaged by anthelmintics, preventing detailed morphological observation and accurate measurement. A careful study using ideally fixed specimens and/or employing some biotechnological methods will clarify the species composition of human pinworms and contribute to the understanding of the coevolutionary process of pinworms and primates.

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Some Aspects of Experimental Infections of *Trichostrongylus axei* in Domestic Rabbits (*Oryctolagus cuniculus*)

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ABSTRACT: *Trichostrongylus axei* have been maintained in domestic rabbits (*Oryctolagus cuniculus*), by serial passage, at the University of Kentucky since 1953 for an equine strain (A) and 1954 for a bovine strain (O). On 17 August, 1995, this research was terminated. Presentation here is mostly on cumulative data on number of serial passages, infectivity, and longevity of *T. axei* since 1984/1985. Comparison is made with earlier research, much of which has been published (Lyons et al., 1987).

KEY WORDS: *Trichostrongylus axei,* nematode, experimental infections, longevity, domestic rabbits.

The domestic rabbit is an excellent host for *Trichostrongylus axei,* not only for study of this parasite but also for providing a source of larvae for research in other hosts (Drudge et al., 1955; Leland and Drudge, 1957; Leland et al., 1959a, b, 1960a, b, 1961; Leland, 1963; Lyons et al., 1987). Advantages of the rabbit as a donor are its small size, potential life span of several years, and prolonged patency of >5 yr for *T. axei* (Lyons et al., 1987).

Two strains (A from equids and O from bovids) of *T. axei* were isolated and established in 1953 (Strain A) and in 1954 (Strain O) in domestic rabbits. Both strains were maintained in rabbits, by serial passage, until 17 August, 1995, when this research was terminated. Strain O was temporarily lost in rabbits on 24 September, 1959 but restarted in this experimental host on 5 November, 1959 from calves previously infected with this strain. More complete records on the infections involved in these serial passages of *T. axei* in rabbits have been kept since 31 July, 1962. From that date through 25 October, 1985

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